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# ACIDIC PRECIPITATION IN ONTARIO STUDY

# QUALITY ASSURANCE PLAN
# APIOS DEPOSITION MONITORING PROGRAM

February 1984

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Ministry
of the
Environment
Ontario

The Honourable
Andrew S. Brandt
Minister

Brock A. Smith
Deputy Minister

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# ACIDIC PRECIPITATION IN ONTARIO STUDY

# QUALITY ASSURANCE PLAN
# APIOS DEPOSITION MONITORING PROGRAM

FEBRUARY 1984

ARB-76-84-ARSP

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## TABLE OF CONTENTS

| Section | | Pages | Revisions | Date |
|---|---|---|---|---|
| 1.0 | INTRODUCTION | 2 | 0 | 30/09/83 |
| 2.0 | OBJECTIVES | 2 | 0 | 30/09/83 |
| 3.0 | ORGANIZATION AND RESPONSIBILITY | 2 | 0 | 30/09/83 |
| 4.0 | NETWORK REPRESENTATIVENESS | 2 | 0 | 30/09/83 |
| 5.0 | INSTRUMENTATION | 1 | 0 | 30/09/83 |
| 6.0 | TRAINING | 2 | 0 | 30/09/83 |
| 7.0 | SAMPLE COLLECTION | 3 | 0 | 30/09/83 |
| 8.0 | SAMPLE MEASUREMENTS | 2 | 0 | 30/09/83 |
| 9.0 | DATA MANAGEMENT | 1 | 0 | 30/09/83 |
| 10.0 | EXTERNAL AUDITS | 1 | 0 | 30/09/83 |
| 11.0 | QUALITY ASSURANCE REPORTS | 1 | 0 | 30/09/83 |
| 12.0 | DOCUMENTATION AND DOCUMENT CONTROL | 1 | 0 | 30/09/83 |
| REFERENCES | | 1 | 0 | 30/09/83 |

## 1.0 INTRODUCTION

The Acidic Precipitation in Ontario Study (APIOS) deposition monitoring program collects precipitation and air filter samples to determine the concentrations and the levels of wet and dry deposition of acids, sulphates, nitrates and trace metals in Ontario. This quality assurance (QA) plan has been developed to ensure that high quality data are reported from the monitoring program.

The APIOS deposition program consists of two types of monitoring networks: an event network and a cumulative network which collect precipitation and air filter samples over a daily and 28-day basis respectively.

The event precipitation network is comprised of 16 monitoring sites located across Ontario which employ Aerochem Metrics wet-only precipitation collectors and precipitation gauges. The event air sampling network consists of 4 air sampling monitoring sites which employ Metrex sequential air samplers. Samples are collected on a daily basis at 0800 hours local time. The objectives of the event networks are:

i) to study the chemical composition, frequency, and intensity of acidic precipitation episodes in the province;

ii) to determine the wet deposition of acid-related materials associated with air masses originating from different directions and, hence, from different emission source regions;

iii) to determine the amount and origin of airborne acid-related pollutants available for deposition in Ontario on a daily basis;

iv) to estimate dry deposition rates of these pollutants on a daily basis by using airborne concentrations and appropriate deposition velocity values.

The cumulative precipitation network is comprised of 37 monitoring sites which employ M.I.C. Type "A" (formerly called Sangamo) wet-only precipitation collectors and precipitation depth storage gauges. Located at 24 of these cumulative precipitation sites are Metrex low-volume air samplers installed to collect air filter samples. Samples are collected over a 28-day period at 0800 hours local time. The objectives of the cumulative network are:

i) to study the chemical composition of cumulative precipitation samples (collected on a 28-day cycle) within the province.

ii) to determine the long-term wet deposition distributions of various chemical parameters across the province.

iii) to determine the ambient concentration of airborne acid-related pollutants on a cumulative (28-day) basis.

iv) to infer dry deposition by using airborne concentrations with appropriate deposition velocity values.

Monitoring site locations of both networks are presented in Figures 1 and 2.

This plan outlines the QA activities which are to form an integral part of the APIOS monitoring program. It should be noted that some of the activities outlined in this plan have been part of the APIOS program from its original inception. Routine technical and operating procedures are not described within this plan but are contained in a separate document entitled "APIOS Technical and Operating Manual" (1). The details of the QA procedures and requirements outlined in this plan are contained in a separate document entitled "APIOS Quality Assurance Manual". The QA manual will serve to guide personnel in carrying out this plan. Corrective action procedures and responsibilities are described in detail in the QA Manual.

## 2.0 QUALITY ASSURANCE OBJECTIVES

The overall objective of the QA plan is to ensure that the collection and reporting of data are complete, accurate, precise, and representative. To meet this objective, QA activities are established within this plan to satisfy the following requirements.

i) All monitoring sites should meet acceptable siting criteria. Any deviations from these criteria should be documented and data collected from these sites closely scrutinized.

ii) Instrumentation, sample collection, sample handling, analysis, and data reporting procedures should be sound. Documentation of these standard operating procedures should be readily available to all personnel.

iii) Standard operating procedures should be used by all personnel at all times. Personnel should be thoroughly trained in using these procedures.

iv) Duties and responsibilities of all program personnel should be documented and distributed to all members.

v) Estimates of accuracy and precision should be established by the use of calibrations, standards, co-located samples, duplicates, blanks, spikes, and other activities or special studies that provide this information.

vi) Corrective action procedures should be established to identify and rectify problems as they arise. Preventive maintenance procedures should be established to minimize instrumentation downtime.

vii) The quality of the data should be monitored and reported on a regular basis.

viii) Audits, both internal and external, should be carried out to
    a) verify that requirements i) to vii) have been properly implemented.
    b) assess the performance of the individual systems in the monitoring program.

Specifically, the following QA objectives are specified below in terms of representativeness, completeness, accuracy, and precision for the APIOS monitoring program.

## REPRESENTATIVENESS

All sites are to be representative of their sampling area. Collected samples are to represent the chemical composition and amount of precipitation within a 50 km radius of the sampling site.

## COMPLETENESS

90% of all samples are to provide chemical data.

## PRECISION AND ACCURACY

To provide data with a precision of ± 20% and an accuracy of ± 20% for all acid-base related parameters.

The following QA procedures are to fulfill the above 8 requirements and to meet the stated objectives in terms of representativeness, completeness, precision and accuracy. Corrective action procedures are to be documented in the QA manual to allow personnel to readily identify, report, and take action to solve any problems in attaining these objectives.

## 3.0 ORGANIZATION AND RESPONSIBILITY

The APIOS monitoring program is carried out by the Special Studies Unit which is part of the Atmospheric Research and Special Programs Section of the Air Resources Branch.

The monitoring networks are administered from the headquarters located in Toronto. Environmental technicians are located throughout Ontario in five Ministry offices, namely Thunder Bay, Sudbury, Dorset, London, and Kingston. Each environmental technician is responsible for the installation, operation, and maintenance of equipment in their respective regions. Every monitoring site has a designated site operator who collects the samples. These operators are primarily either private citizens, or employees of the Ministry of the Environment and Ministry of Natural Resources, who have agreed to collect samples and have equipment installed on their property.

Sample analysis is carried out by the Water Quality Section (WQS) and Inorganic Trace Contaminants Section (ITC) of the Ministry's Laboratory Services and Applied Research Branch. The laboratory is located on Resources Road in Rexdale, Ontario.

Shown in Figure 3 is the organizational chart for the APIOS program. The Atmospheric Deposition and Chemistry Program Leader will be designated as the QA manager. This position's responsibilities will include overseeing all aspects of the QA program and ensuring that high quality data are generated within time and funding constraints of the monitoring program.

The implementation and co-ordination of the QA plan will be carried out by the Technical Co-ordinator, herein referred to as the QA co-ordinator. This position will be responsible for overseeing all QA procedures and requirements that are to be implemented as part of this plan.

In the laboratory, an internal quality assurance office has implemented a comprehensive QA/QC program for the entire laboratory. Ensuring the use of proper laboratory procedures and quality control steps on a day-to-day basis in the laboratory is to be the responsibility of laboratory supervisors and the laboratory QA office.

A detailed organizational chart is to be documented showing all staff relationships and lines of authority. Positions in the APIOS program (including relevant laboratory staff) are to be documented outlining all duties and responsibilities as they relate to the APIOS program. This documentation is to be incorporated into the QA Manual.

Quality assurance responsibilities and duties associated with each QA activity are to be described in detail in the QA Manual to ensure that personnel know the QA requirements and responsibilities of their positions. The inter-relationships and co-ordination between laboratory personnel and APIOS network personnel are to be explained and documented in detail in the QA Manual. Corrective action procedures and responsibilities are to be included in all job descriptions.

## 4.0 NETWORK REPRESENTATIVENESS

The design of the network is based on the objectives of the monitoring program. The design of both the daily and 28-day network is to be documented. Site selection criteria should be documented and used to evaluate all APIOS monitoring sites.

Monitoring sites are to be fully documented and evaluated to determine their representativeness. Site description documentation is to include the following:

i) location of site including station name, number, latitude, longitude, UTM co-ordinates, and elevation. A topographic map is to be on file for every site.

ii) type of equipment installed at site, including name of manufacturer and model numbers.

iii) name, address, and telephone numbers (home and work) of operator and of any operator alternates.

iv) site logistic information such as access during summer and winter, type of electrical service at site, and a description of any other logistical problems (e.g. locked gates, guard dogs, etc.).

v) topography and land use (including soil type and ground cover, windbreaks, prevailing winds, and locations of any objects or obstructions near sampler).

vi) description of human and vehicular activity near the site.

vii) location of stationary pollutant sources including distances and directions from the site. Descriptions of any other potential sources such as nearby agricultural operations are to be included in this documentation.

viii) a summary of the site including advantages, disadvantages, and any deviations from siting criteria.

ix) a written description of how to travel to the site.

x) a site diagram including the position of samplers and gauges location and type of surrounding windbreaks, buildings, roads (if applicable), ground cover, obstructions, potential contamination sources, electrical installation, and compass points. Distances in meters are to be clearly marked on all site diagrams.

xi) 5 site photographs (4 compass points, 1 close-up) clearly showing the sampling instrumentation and all areas surrounding the site.

The environmental technician responsible for the site is to qualitatively rank the site in one of the following categories: Excellent, Good, Marginal, or Poor. The description of each category and guidelines to rank the sites should be documented to maintain consistency between technicians.

Based on the site documentation, photographs, and rankings, an evaluation is to be undertaken to determine the representativeness of each site. This evaluation is to be carried out by the QA co-ordinator with at least one other APIOS program member. Copies of the evaluations are to be submitted to the QA manager and the database scientist. Sites ranked Marginal or Poor are to be either improved or removed from the program. Any data collected from these sites are to be closely scrutinized by the QA co-ordinator and database scientist.

Monitoring sites change to some extent over the course of time. To determine whether existing sites still meet siting criteria, a re-evaluation of every site is to be undertaken every two years. This re-evaluation is to consist of updating site documentation, including re-photographing all sites, and re-evaluating the site rankings. A report, prepared by the QA co-ordinator, is to be submitted to the QA manager and database scientist.

Any site changes that occur between evaluations are to be immediately reported by the environmental technician responsible for the site to the QA co-ordinator. A form entitled "Site Change Notification" is to be developed to include any site change, operator change, property-owner change, or any other administrative change affecting the site. The effect of this change on the quality of data collected from the site is to be immediately evaluated by the QA co-ordinator.

Corrective action procedures and responsibilities are to be developed and documented in the QA manual.

## 5.0 INSTRUMENTATION

Field instrumentation is one of the most important factors in meeting the objective for completeness in the APIOS program. Instrument downtime in the field program contributes to the loss of data more than any other factor. All precipitation collectors, precipitation gauges, air sampling equipment,and any other equipment are to be tested for acceptance prior to use in the field. Detailed operating, maintenance, and service guidelines, as well as schematics and mechanical drawings are to be made available prior to these purchases. Procedures are to be developed and documented for acceptance testing of all equipment.

Equipment is to be calibrated, installed, and maintained by following uniform guidelines which are to be developed and documented. All instruments must be within an acceptable calibration range prior to installation and operation in the networks. Routine calibrations and preventive maintenance procedures are to be implemented into the network. The frequency and scheduling of these procedures are to be developed and distributed. Environmental technicians are to submit, on a regular basis, records of all calibrations and preventive maintenance to the QA co-ordinator.

For laboratory operations, acceptance testing, calibration, and preventive maintenance procedures are to be developed and documented. The supervisors of the laboratory sections are responsible for overseeing the proper installation and operation of all laboratory equipment.

Supplies, parts, and spare equipment are to be maintained at the headquarters as well as the field office and monitoring site. Inventories are to be taken monthly at the headquarters to ensure sufficient supplies and equipment are available to maintain the networks. Environmental technicians are to take inventory of their supplies every six months and submit a supplies request. The supplies requests are to be co-ordinated by the technician in Toronto. It is the responsibility of the environmental technicians to maintain their operators' supplies and it is the QA co-ordinator's responsibility to ensure that sufficient supplies and equipment are available for the environmental technicians.

Corrective action procedures are to be developed and documented.

## 6.0 TRAINING

The monitoring networks rely heavily on the on-site operators to collect samples following standard operating procedures. Training, therefore, is of utmost importance in meeting the QA objectives.

Every new operator is to be thoroughly trained by the environmental technician responsible for the site. The operator is to have a complete set of technical and operating procedures. These documented procedures are to be kept up-to-date at all times. It will be the responsiblity of the QA co-ordinator to update these procedures, and the environmental technicians' responsibility to distribute these updated procedures and re-train the operators.

Similarly, the environmental technician's training is vital and if not complete, will eventually reflect upon the operator's training. All new technicians are to receive thorough training by receiving at least one week of intensive training at the headquarters, and at least one week of on-the-job training with an environmental technician operating out of one of the five regions.

Any new operators or technicians are to be closely observed during these training periods to determine if additional training is required. The QA co-ordinator, in consultation with the appropriate environmental technician providing the operator training or the on-the-job training, is to determine this requirement.

Technician meetings are to be held quarterly at the headquarters. During these meetings, the technicians, QA co-ordinator, and other program staff are to discuss the network operations in the various regions. These meetings allow vital communication, feedback, and any re-training, which are required in maintaining a large sampling network such as APIOS, to take place.

Similarly, an operator newsletter is to be prepared and distributed every six months to maintain a communication link between the operators and head office. This newsletter is to be used to keep network operators aware of network status, future plans, special studies, and other scientific developments which occur in the acidic precipitation field.

Laboratory training is to be the responsibility of the laboratory section supervisor. These supervisors are to ensure that new staff are properly trained. Proficiency checks should be carried out prior to leaving any new analyst to perform routine sample analyses. Detailed operating and procedure documents are to be available for all sample preparations and analytical methods.

## 7.0 SAMPLE COLLECTION

Detailed up-to-date documentation is to be prepared for all sample collection procedures. Within these procedures, the following QA activities are to be implemented into the networks.

### 7.1 Event Precipitation Network

To assess whether the collection system is operating properly, samples of known concentrations are to be handled by the operator and submitted to the laboratory following standard operating procedures. This procedure is to be carried out quarterly at every event site.

Since sample bags in the event network are only removed after a precipitation event has been collected, dry bags (bags that have been inserted into the collector but not exposed to precipitation) chosen randomly are to be submitted by the operator to the laboratory as field blanks. One field blank should be submitted from each site for every sampling month. The analyses of these samples are to quantify dry deposition that is collected in the wet deposition samples during days of no precipitation.

To help estimate field handling and laboratory operations precision in the event network, samples of sufficient volume are to be split and submitted as duplicate samples.

To estimate the overall precision of sampling equipment, field handling, and laboratory operations, one co-located event site is to be installed in every region. At these sites, two Aerochem Metrics collectors and two precipitation gauges are to be co-located year round.

Technicians are to audit the handling procedures used by the site operator every year to ensure that the operator's procedures are those specified in the technical and operating manual. This internal operator audit can be carried out using a spare bucket and sample bag and by verbally questioning the operator regarding specific procedures. A known volume of water is to be emptied into the precipitation gauge and measured by the operator. Results of the audit are to be reported to the QA co-ordinator by using a standard audit questionnaire form. If any procedural differences are noted, the corrective actions taken by the technician are to be documented on the questionnaire.

Sample bottles obtained from central stores of the Laboratory Services Branch are to be tested for their integrity (sorption of precipitation constituents). For every batch of sample bottles obtained for use in the event network, three bottles containing de-ionized distilled water, three bottles containing acidified de-ionized distilled water, and three bottles containing a composite precipitation sample will be tested. Similarly, the integrity of new event sample bags purchased from the supplier are to be checked by submitting nine bags for analyses under the same conditions as the event bottles, prior to use in the field.

Bags are also to be submitted (one bag per region) from the technician's inventory on a quarterly basis for blank analyses. The blank analyses will be carried out using de-ionized distilled water.

### 7.2 Cumulative Precipitation Network

Similar QA samples and checks are to be incorporated into the cumulative precipitation network. Composite samples are to be handled annually by the operator, at each site, and operator audits are to be carried out annually by the technician.

Co-located cumulative precipitation monitoring sites are to be installed to estimate precision. One site in every region is to be equipped with a co-located precipitation collector and a co-located precipitation gauge.

To ensure the integrity of sample bags used in the cumulative network, nine bags are to be analysed under similar conditions as the event network sample bags from every new batch of bags purchased from the bag manufacturer.

Bags are also to be submitted from the technicians inventory for blank analyses. Quarterly, each technician is to submit a winter time and summer time sample bag for blank analysis using de-ionized distilled water.

### 7.3 Air Sampling Networks

Blank filters from every batch purchased or prepared (impregnated W-41's) are to be submitted for blank analyses prior to deployment in the field program. Three filters of each filter type from every lot number are to be analysed.

Handling blanks are to be submitted quarterly by technicians who are each to load a filter pack which is characteristic of each type of network. These loaded packs are to be shipped to the headquarters where they are to be unloaded by the environmental technician operating out of Toronto. The "handled" filters are to be submitted for analyses.

To determine the precision of the air sampling networks, co-located air sampling equipment is to be installed in both the cumulative and event networks. In the cumulative network, a co-located Metrex low-volume air sampler is to be installed in every region. In the event network, one co-located Metrex sequential air sampler is to be installed in Dorset.

Technicians are to audit the cumulative air sampling operators annually to observe their handling procedures. Standard audit questionnaire forms are to be used and the completed forms are to be sent to the QA co-ordinator.

## 7.4 Special Studies

Special studies are to be undertaken to estimate precision and accuracy in both the cumulative and event sampling networks. These studies should be designed to provide estimates which can be applied directly to determine the quality of data collected in the APIOS networks. These studies are to be undertaken by the special studies scientist. Each special study is to be documented specifying the study objectives, operating procedures, QA procedures, and reporting procedures, prior to starting the study. All studies are to be approved by the QA manager.

## 8.0 SAMPLE MEASUREMENTS

All analytical techniques and other measurement methods used in the APIOS program are to be documented in the QA Manual. The documentation is to include a description of the method or technique, the precision and accuracy of each technique, operating procedures, and calibration procedures. Other QA procedures such as recovery checks, sensitivity checks, and duplicate analyses checks, are to be included in the documentation if applicable. Corrective action procedures are to be documented for all these QA procedures.

### 8.1 Field pH Measurement Checks

Field pH meters are calibrated prior to measuring field pHs. Buffer solutions of pH 4.00 and pH 7.00 are used to calibrate the meter. To ensure the accuracy and precision of field pH meters, dilute $HNO_3$ (.002 N), between pH 3.5 and 4.0, is to be distributed quarterly to environmental technicians for triplicate pH measurements. Every measurement is to be within ±0.05 pH unit or corrective action is to be taken.

### 8.2 Volume Measurement Checks

Known volumes of water are to be distributed quarterly to environmental technicians to be weighed and converted to a volume. Results are to be within ±5% of the true volume or corrective action is to be taken.

### 8.3 Sample Analysis

Analytical equipment in the central laboratory is to be calibrated regularly using calibration reference standards. Control standards are to be used to detect deterioration in instrumentation, chemicals, or handling technique. If the instrument is not within required specifications, it is to be immediately recalibrated. Sensitivity checks and duplicate analyses are to be implemented to insure accurate and precise results.

The Water Quality and Inorganic Trace Contaminants Sections are to participate in intra-laboratory comparisons at least once every year. The results of these comparisons are to be sent to the QA co-ordinator.

Quarterly, QC standards are to be submitted as blind samples from the head office to the laboratory. Results of these submissions are to be made available to the lab supervisors after analyses are complete.

Laboratory data quality reports are to be prepared on an annual basis. Quality control data are to be made available to the QA co-ordinator on a semi-annual basis for inclusion in the APIOS semi-annual QA reports. The QA co-ordinator and QA manager are to meet with the laboratory supervisors and laboratory QA officers to discuss the results generated by the QA program. These meetings should take place semi-annually and are considered vital in maintaining communication between field and laboratory operations.

## 9.0 DATA MANAGEMENT

The data management system is to be documented. Data handling in the field and laboratory is to be documented and reviewed to isolate potential areas for errors. These potential error areas are to be monitored, either by manual or computer methods, to determine the frequency of errors, source of errors, and the corrective actions that need to be taken.

### 9.1 Sample Collection Summaries

Summaries of the samples collected (e.g. station name, volume, date) and precipitation depths, are to be recorded on a summary sheet in the event precipitation network. The technicians are to prepare these summaries and send them to the QA co-ordinator for review. Any abnormalities in the number of samples collected, or the dates of collected samples, are to be brought to the attention of the technician by the QA co-ordinator for corrective action.

Similarly, a summary sheet for the collection of cumulative samples is to be prepared by the technicians and sent to the QA co-ordinator. These summary sheets are to be used to quickly identify inconsistencies or sample capture problems (consistent malfunctions, bag leaks, etc.)

### 9.2 Data Validation and Screening

Data validation and screening techniques are to be documented in detail in the QA Manual. Manual comparisons and reviews of selected field data and laboratory data to the final data files are to be carried out annually. These manual comparisons are to utilize one month of event data and three months of cumulative data from all sites. Flags appended to any of these data are to be subjectively re-evaluated.

### 9.3 Data Reporting

Data are to be reported on an annual basis. Schedules are to be developed for the production of these reports. Summaries of the data quality which are to be based on the findings of the semi-annual QA reports are to be included in these reports.

## 10.0 EXTERNAL AUDITS

To independently assess the quality of the data in the monitoring networks, external audits are to be carried out. These audits are to consist of systems and performance audits to qualitatively and quantitatively assess the networks' performance. The overall objective of these audits is to verify that the APIOS deposition program is effectively producing data that are complete, representative, precise and accurate. To meet this objective, the auditor is to:

i) evaluate the representativeness of sites in the networks (25% of sites per year)
ii) assess the collection and measurement systems of the networks
iii) assess the data management system
iv) evaluate the QA/QC program to ensure that it meets its stated objectives.

Annually, an auditor is to be chosen to carry out the audits. A final auditor's report is to be prepared and submitted to the QA manager. The report is to contain the results of the systems and performance audits including details of the site evaluations, technician and operator assessments, and results of the evaluation of the data management system. Weaknesses, strengths, and recommendations generated by these evaluations are to be reported in detail. Any previous audit recommendations are to be followed up by the auditor to determine if these recommendations were implemented, and if not, why they were not implemented. Results of these audits are to be incorporated into the semi-annual QA reports prepared by the QA co-ordinator.

## 11.0 QUALITY ASSURANCE REPORTS

Annually, a quality assurance report is to be prepared by the QA co-ordinator summarizing the results of the QA program over a twelve-month period. The following information is to be included in these reports.

i) Statistics of sample and data capture (completeness).

ii) Results of blank, duplicate, composite, blind, and co-located samples analyses (precision and accuracy).

iii) Results of special studies (precision and accuracy).

iv) Laboratory Q.C. data (precision and accuracy).

v) Results of internal and external audits.

vi) Status of data (projected schedules for data reports).

vii) Problems, recommendations, and corrective actions to be taken.

These reports are to be submitted to the QA manager for review and are to be distributed to all members of the monitoring program and to all data users on request.

## 12.0 DOCUMENTATION AND DOCUMENT CONTROL

Keeping documentation up-to-date is essential for any scientific program or study. To meet this requirement, documentation is to be updated on an annual basis. Any changes in operating procedures, such as sample handling, are to be immediately updated and distributed to all personnel. The following format is to be used for all documents in the program.

Section No:
Revision No:
Date:
Page: ___ of ___

A file is to be maintained with the names and addresses of all personnel (internal or external) who have a copy of the document. Any revisions, therefore, can be immediately mailed to the holders of these documents. It will be the responsibility of the laboratory supervisors to update laboratory documentation. Technicians and external auditors should check on site operating manuals to ensure that they are up-to-date. The QA co-ordinator is to be responsible for all other program documentation.

A listing and description of all available documentation is to be prepared for the monitoring program. This listing is to be incorporated into the QA Manual and made available to all program members.

# REFERENCES

1. Bardswick, W.S., 1983: "APIOS Technical and Operating Manual". Ontario Ministry of the Environment, Air Resources Branch, April 1983.

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3. Topol, L.E., Flanagan, J., Chen, P., Lev-On, M., Schwall, R. and Shepard, L.S., 1981: "Quality Assurance Manual for Precipitation Measurement Systems". Rockwell International Contract No. 68-02-3262.

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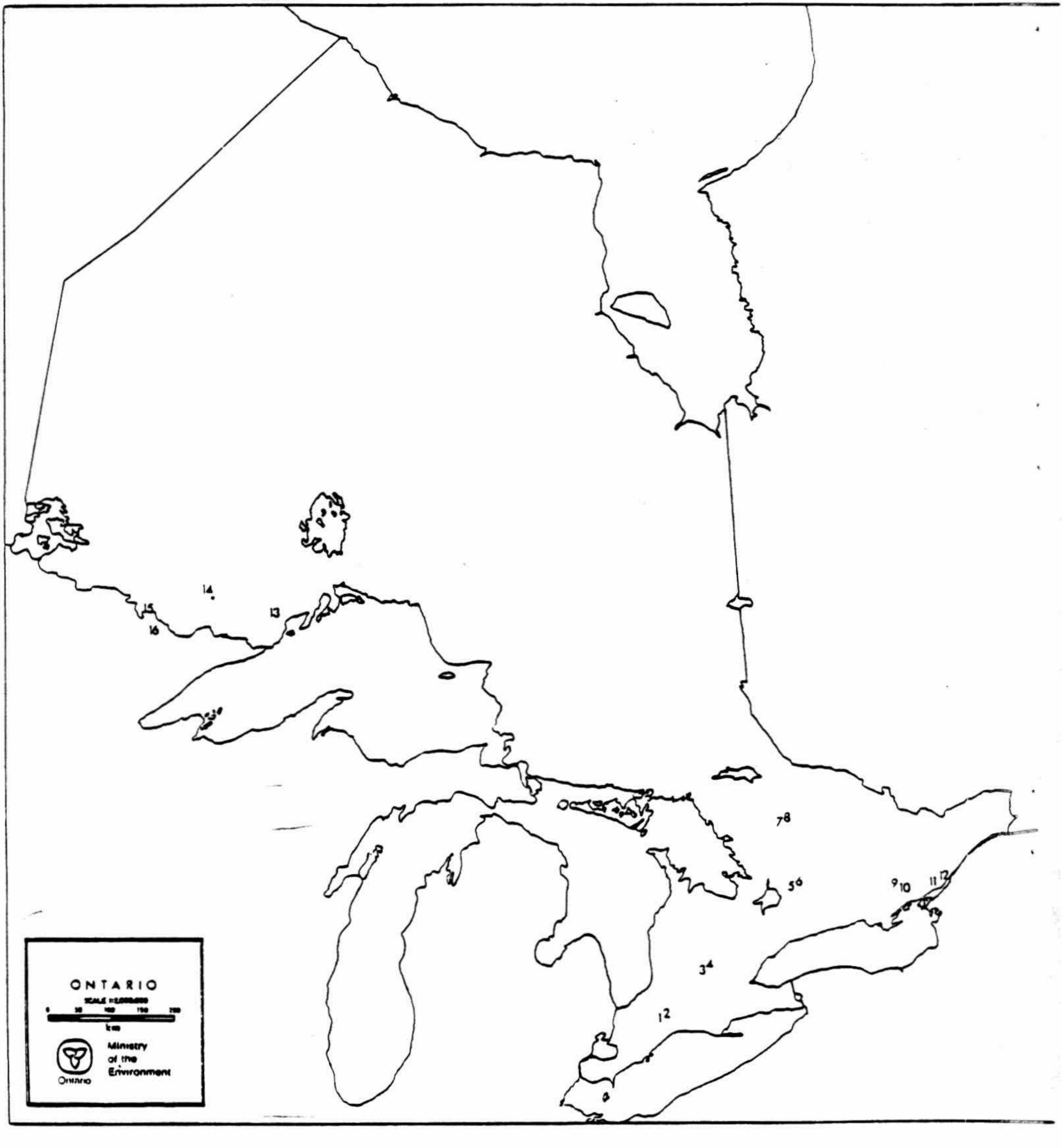
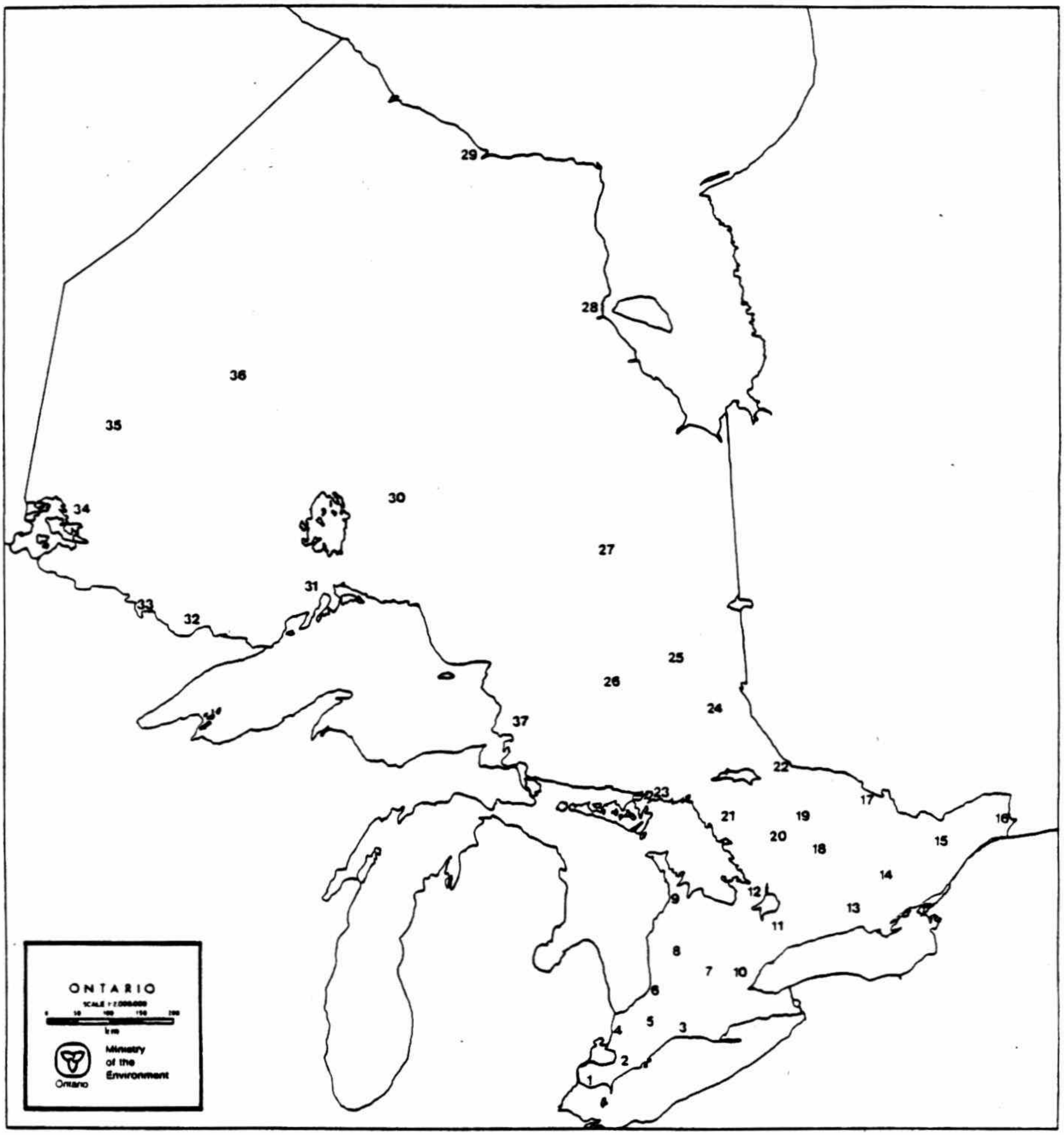
5. Onlock, S.G., Personal Communication, 1983.

Fig.1 Station Location Map
Event Network



1 - MELBOURNE
2 - LONGWOODS
3 - NORTH EASTHOPE
4 - WELLESLEY
5 - RAVEN LAKE
6 - BALSAM LAKE
7 - NITHGROVE
8 - DORSET
9 - WHITMAN CREEK
10 - RAILTON
11 - CHARLESTON LAKE
12 - GRAHAM LAKE
13 - FORBES TOWNSHIP
14 - QUETICO CENTRE
15 - LAC LA CROIX
16 - FERNBERG

Fig.2 Station Location Map
Cumulative Network



1 - COLCHESTER
2 - MERLIN
3 - PORT STANLEY
4 - WILKESPORT
5 - ALVINSTON
6 - HURON PARK
7 - WATERLOO
8 - PALMERSTON
9 - SHALLOW LAKE
10 - MILTON

11 - UXBRIDGE
12 - COLDWATER
13 - CAMPBELLFORD
14 - CLOYNE
15 - SMITH'S FALLS
16 - DALHOUSIE MILLS
17 - GOLDEN LAKE
18 - WILBERFORCE
19 - WHITNEY
20 - DORSET

21 - MCKELLAR
22 - MATTAWA
23 - KILLARNEY
24 - BEAR ISLAND
25 - GOWGANDA
26 - AZURE LAKE
27 - MOONBEAM
28 - ATTAWAPISKAT
29 - WINISK
30 - GERALDTON

31 - DORION
32 - QUETICO CENTRE
33 - LAC LA CROIX
34 - EXP. LAKES AREA
35 - EAR FALLS
36 - PICKLE LAKE
37 - TURKEY LAKE

Fig.3 ORGANIZATIONAL CHART